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(54) Abstract Title
Identifying transponders on difficult to read items

(57) A transponder device reading system is used with a storage means, container or packaging element, in order to identify goods 1. The transponder device reading system consists of at least one transponder device, a transponder device reader 11 and a radiating element 7. The reader includes an antenna 10 which emits an interrogation radio signal and receives a response radio signal emitted by the transponder device(s) in response to the interrogation signal. The radiating element has a radiating portion 9 which couples radio signals to and from the antenna of the reader and another radiating portion 12,12',12" which couples radio signals to and from the transponder device(s). The radiating element is arranged to transfer radio signals emitted by the antenna of the reader to the transponder device(s) and vice-versa, and can be mounted in or on the container or packaging element. May be used to identify beer kegs, shelved boxes and items stored in metal enclosures.

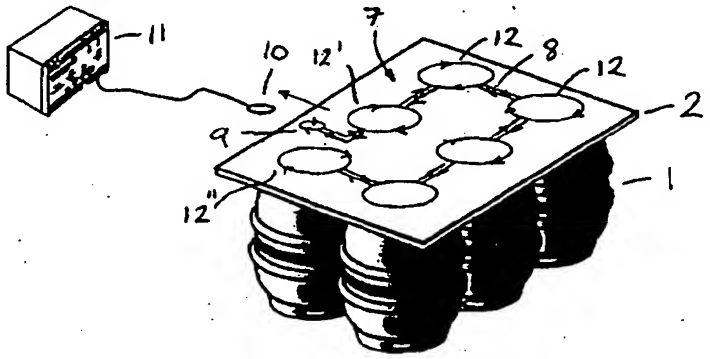

Fig. 3

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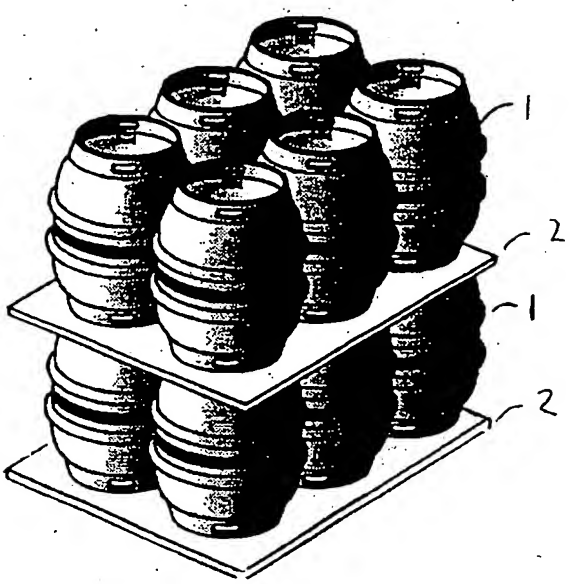

Fig. 1

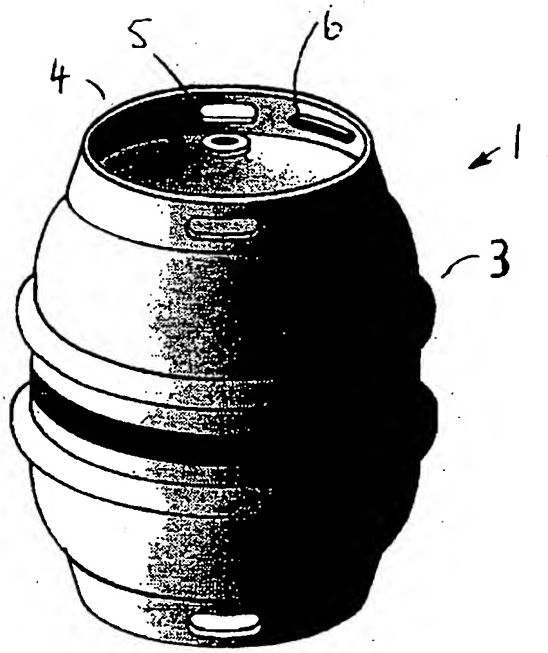

Fig. 2

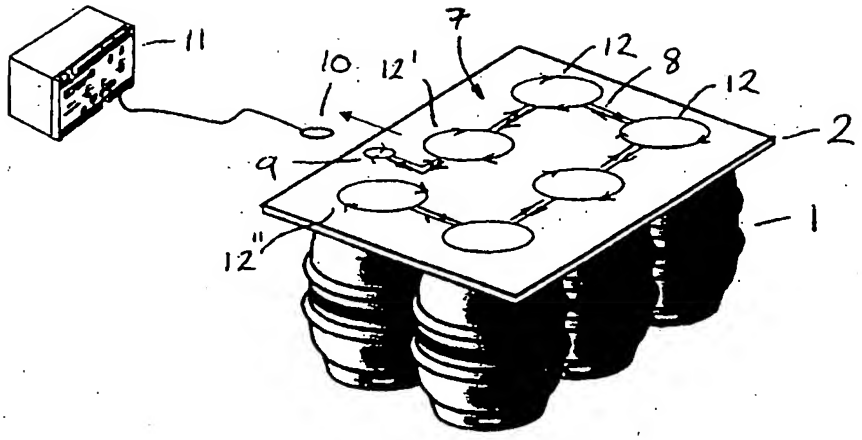

Fig. 3

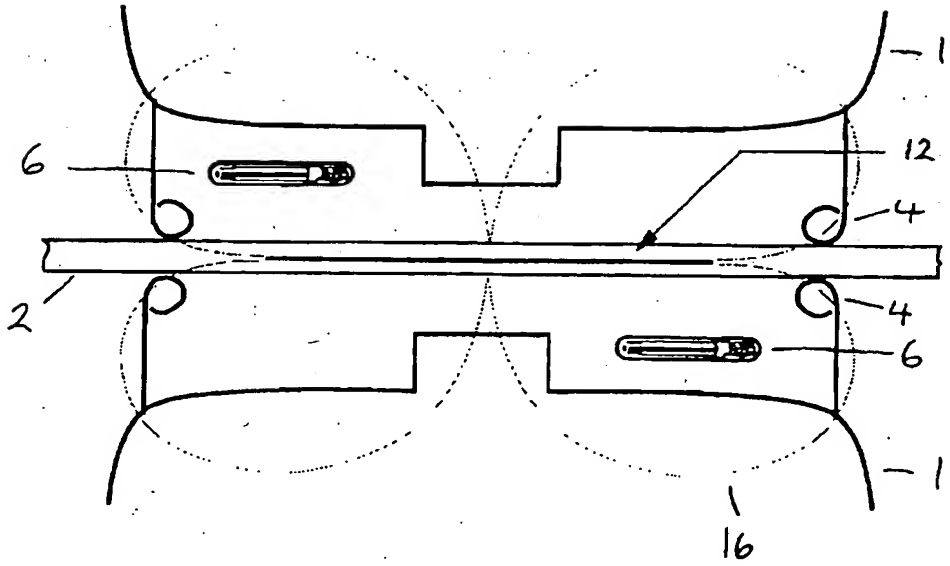

Fig. 4

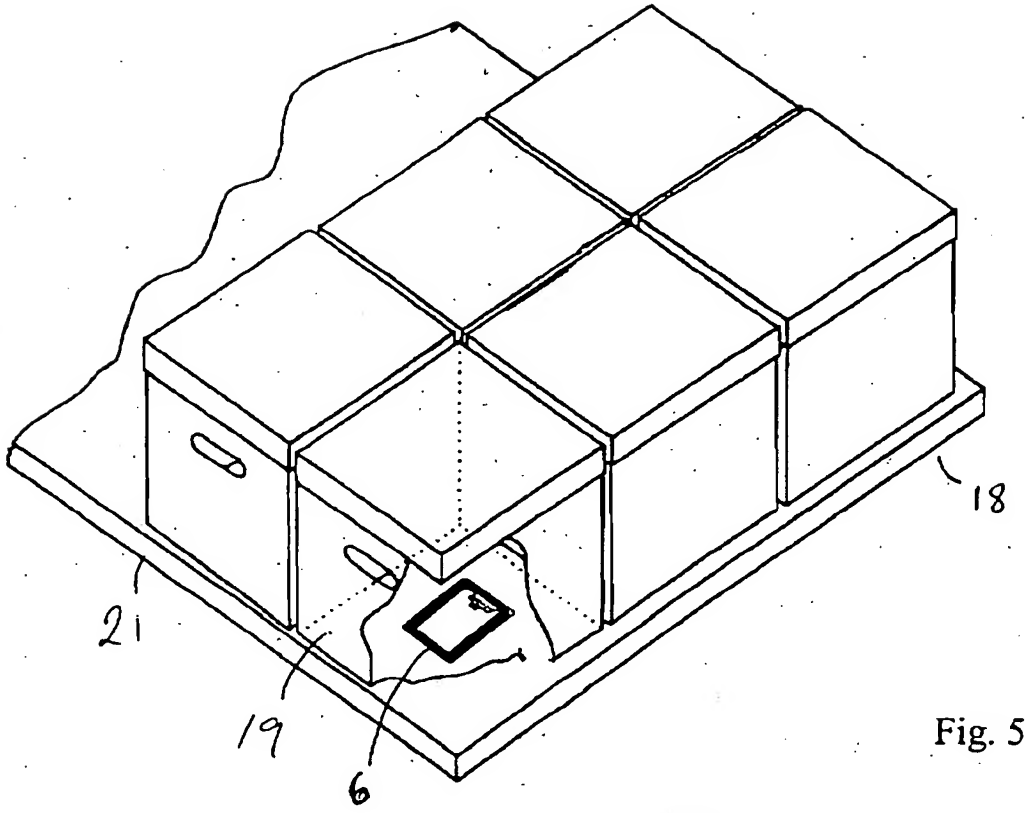

Fig. 5

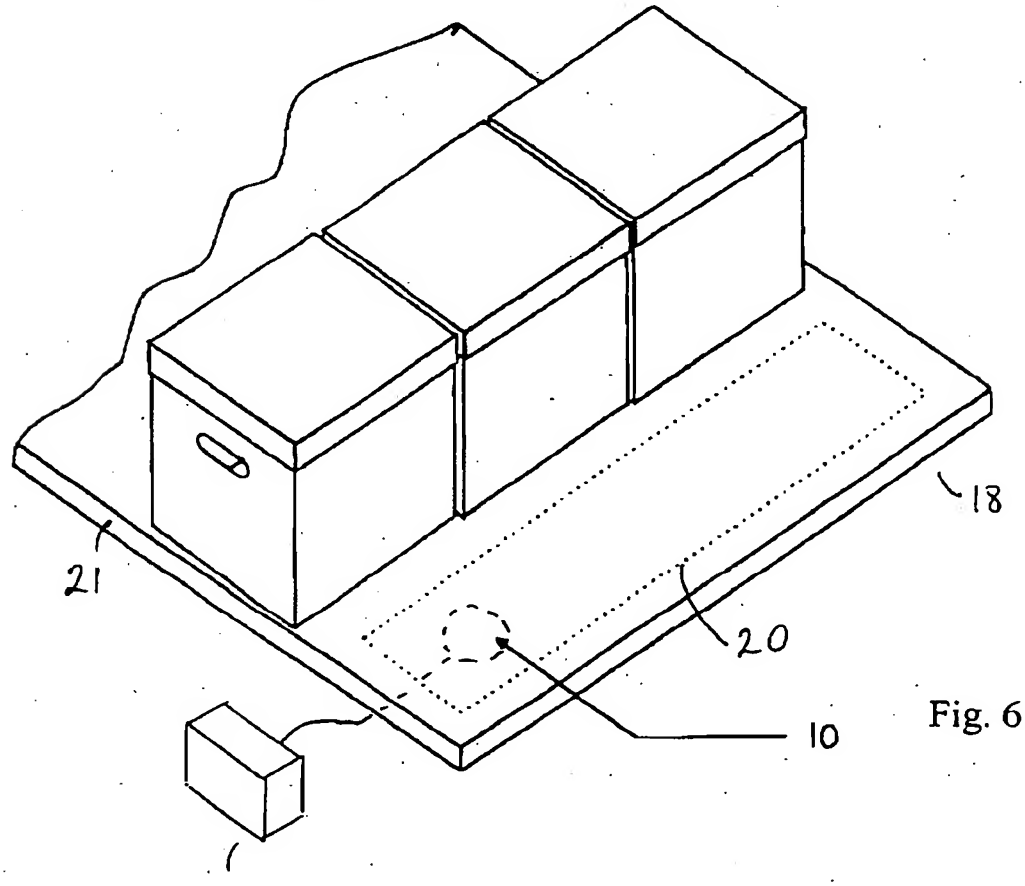

Fig. 6

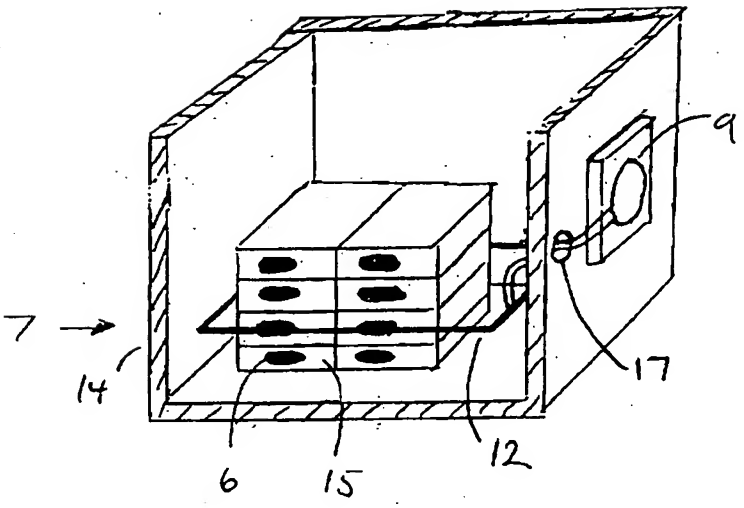

Fig. 7

IMPROVEMENTS IN OR RELATING TO RADIO ID DEVICE READERS

The present invention relates to radio frequency devices used to identify, for example, goods.

As is known in the art, radio transponders may be attached to goods to identify them. The presence of goods in, for example, a stockroom is detected by passing a reader over the goods. The reader emits an interrogation signal which is received by a transponder attached to a nearby item. The transponder responds by emitting an identifying signal, for example a unique identifying number, or a code identifying the type of the goods.

It is possible that the signal from the reader will be received and responded to by more than one transponder. In such circumstances, as is known in the art, an anti-collision algorithm is used to ensure that that the transponders are read in turn.

The positioning of the devices on some kinds of goods (and the materials from which those goods are made) make it difficult for the reader to read the transponder devices on those goods. It is an object of the present invention to alleviate that problem.

According to a first aspect of the present invention there is provided a transponder device reading system comprising:

at least one transponder device;

a transponder device reader comprising an antenna for emitting an interrogation radio signal and for receiving a response radio signal emitted by the or each transponder device in response to the interrogation signal;

a radiating element having a radiating portion for coupling radio signals to and from the antenna of the reader and a radiating portion for coupling radio signals to and from the or each transponder device,

wherein the radiating element is so coupled to the transponder device reader and to the or each transponder device, and wherein the radiating element is arranged to transfer radio signals emitted by the antenna of the reader to the or each transponder and to transfer radio signals emitted by the or each transponder to the reader.

As stated below the invention may be used with a storage means, container or packaging element. It may, however, be used in other situations. For example, the radiating element could be embedded in the floor of part of a manufacturing line to couple a reader to product on the line.

According to a second aspect of the present invention there is also provided a storage means, container, or packaging element, comprising a radiating element having means for coupling radio signals to and from a transponder device reader and a radiating portion for coupling radio signals to and from at least one transponder device, the radiating element being arranged to transfer an interrogation radio signal emitted by the reader to the or each transponder and to transfer response radio signals emitted by the or each transponder to the reader in response to the interrogation signal, wherein the radiating element is mounted in or on the container or packaging element.

The means for coupling to and from the transponder device reader may comprise a radiating portion of the radiating element for coupling radio signals to and from the antenna of the receiver. Alternatively it may comprise a conductive connector.

According to a third aspect of the invention there is provided a method of reading at least one transponder device with a device reader comprising:

providing a radiating element having a portion for coupling radio signals to and from the antenna of the reader and a portion for coupling radio signals to and from the or each transponder device;

emitting an interrogation signal from the antenna of the device reader;

transferring the emitted interrogation signal to the or each transponder with the radiating element;

emitting a response signal from the or each transponder in response to the interrogation signal; and

transferring the or each emitted response signal to the antenna of the reader with the radiating element.

In any aspect of the invention the said radiating element may be mounted in or on the storage means, container or packaging element.

The radiating element may comprise a conductive loop of at least one turn.

The conductive loop may have a coil of at least one turn providing the said reader coupling portion. The conductive loop may have a coil of at least one turn providing the said transponder coupling portion. Further, the conductive loop may have a plurality of coils of at least one turn each

providing a transponder coupling portion. The conductive loop may have a coil that provides coupling to both the reader and at least one transponder device.

The conductive loop may comprise a wire loop.

The packaging element may be in the form of a separator board for a stack of items. Such a stack may be read by coupling the reader to each said separator board in turn. A stack may be terminated both at the top and the bottom by such a separator board. The items forming a stack may be kegs.

The said storage means may be in the form of a shelf.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying FIGURES, of which:

FIGURE 1 is a partially complete stack of beer kegs.
FIGURE 2 is a beer keg.
FIGURE 3 shows a radiating element according to the present invention incorporated into a separator board.
FIGURE 4 shows the location of a transponder coupling coil of the radiating element between two kegs.
FIGURE 5 shows a set of archive boxes stored on a shelf
FIGUER 6 shows a radiating element for reading the archive boxes.
FIGURE 7 illustrates the use of the invention inside a container.

The present invention may be used with transponders attached to many kinds of goods or other items but the first embodiment described herein relates to beer kegs as they present particular problems. (Kegs are only one form of beer container but the invention may be used with others such as barrels and casks, as indeed it may be used with many other sorts of items.)

Figure 1 shows a partially complete stack of beer kegs. Such a stack is commonly known as a "package" or "pallet load" and may be loaded as a whole onto a vehicle. The stack comprises layers of beer kegs 1 stood on their ends interspersed with separator boards 2. Usually, a separator board terminates the stack at both the top and the bottom to increase the stability of the stack.

The beer keg 1 (Figure 2) usually has an aluminium body 3 with a handling ring or "chime" 4 on each end. The valve,

or "spear", 5 is on the end of the barrel inside the handling ring 4. The handling ring also serves to protect the valve from mechanical damage during handling. The preferred position for a transponder device 6 is for the same reason also within the handling ring, preferably as shown on the inner surface of the handling ring. Since the keg and the handling ring are both made of metal, they will tend to shield a transponder device placed inside the ring from a radio signal from a device reader. When the kegs are placed in a stack, for example, in the manner of Figure 1, a transponder device is completely shielded from radio signals by the opposing barrel ends and handling rings, which means of course that the transponder devices cannot be read by the reader.

Figure 3 shows a separator board 2 incorporating a radiating element 7 according to an embodiment of the present invention. The radiating element comprises a loop of wire 8, which at various points is turned into coils 9,12. A reader coupling coil 9 has two turns of the wire and is of a similar size to the hand-held loop antenna 10 of a reader 11. Several transponder coupling coils 12, each of two turns of the wire, are placed at the sites where the ends of the keg stand on the separator board (or where the barrel supports the separator board if they are below).

The wire 8 may be wound as follows. First the reader coupling coil 9 is wound for two turns in the direction shown by the arrows. The wire is then led to the first reader coil (denoted 12' to distinguish it from the other coils 12) and one and a half turns are made for that. The wire is then led to the other coils 12 in turn and each is given one and a half or one and three quarter turns depending whether the coil is at the corner of the separator board 12 or not. When

the wire has reached the last coil 12'' two turns are made and then the wire is fed back to the previous coil and then the others and finally back to the reader coupling coil 9 where it is cut and the ends are joined to form a complete loop. Note that in Figure 3 between the coils there are two conductors running in close proximity. The coils are wound in the direction shown by the arrows in Figure 3 and on the return path from coil 12'' to coil 9 the wire completes the missing half or quarter turn to make each coil two turns. (It is not essential to wind each coil in the same direction but for any particular coil it is, of course preferable to wind all the turns in the same direction.) It is also possible to wind further loops around the structure from coil 9 to 12'' and back. Each loop may add one or more turns to the coils 9 and 12.

The reader coupling coil 9 absorbs the radio signal from the reader which is then distributed to the transponder coupling coils 12. Here each transponder coupling coil radiates the signal into the space between the kegs 1 inside the handling rings 4 (see also Figure 4). The signal is then received by the transponders which, as usual, respond by emitting an identifying signal. The identifying signal is absorbed by its adjacent transponder coupling coil 12 and is transferred around the wire loop 8. A portion of the identifying response signal is radiated from the reader coupling coil 9 where it is received by the loop antenna 10 of the reader 11, which then records the identity of the transponder. (Other portions of the response signal will, of course, be radiated by the other transponder coupling coils.) Clearly, the radiating element 7 may be coupled to several transponders but the replies from these are managed with an anti-collision algorithm. Note that the transponder devices are not mounted directly on the kegs but are spaced therefrom

by a non-metallic spacer. This is because there will be no radio signal close to the end wall of the beer keg, it being a conductor.

Figure 4 shows in cross section the arrangement of a transponder coupling loop 12 between two kegs 1. Preferably, the transponder coupling coils 12 are centred on the axis of where the kegs are placed and have a slightly smaller diameter to ensure that adequate signal is radiated into all parts of the space between the barrels, so that the transponder 6 receives the signal no matter where it is located within that space. The generally cardioid outline 16 indicates generally the relative intensity of the radio field emitted by the loop 12 in all directions from the loop. (It does not show the radio field penetrating the walls of the keg, which of course does not occur.)

Usually, the separator boards are made from plastic and preferably the radiating element 7 is incorporated within the plastic. This does not affect its function of transferring the signals from the reader to the transponders (and transferring the response signals back); but it does serve to protect the radiating element from mechanical damage. To achieve this, the separator board can be made in two halves, the radiating element lying in a groove in one half and then bonding the two halves together.

To read an entire stack, or package, of kegs each separator board 2 is provided with a radiating element 7 and the loop antenna 10 of the reader is placed on the reader coupling coil 9 of each in turn. If, as mentioned above, a separator board terminates the stack at the top and bottom, then all the ends of all the barrels in the stack will be adjacent to a transponder coupling coil and so all the

transponder devices will be read, irrespective of which way up the barrels are. As shown in Figure 4, it may be that there are two transponder devices within the space between two barrels but both of these may be successfully read using the present invention.

In the embodiment for a stack of beer kegs described above the difficulty in reading the transponder devices was a result of the shape and material of the marked items - the beer kegs - themselves. Similar problems can also arise if the marked goods or items are stored in a container which would shield the transponder devices from the reader. For example, the goods may be kept in metal containers.

While a coil 9 has been shown above for coupling the loop antenna of the reader to the radiating element, it is also possible to dispense with that coil (and the loop antenna) and by connecting the reader directly to the radiating element with a connector. This may be more efficient at transferring the signals but requires the reader to be matched to the impedance of the radiating element. Further connectors do not always provide reliable connections.

Figures 5 and 6 illustrate another use for the invention. Figure 5 shows a shelf 21 on which are stored a number of archive boxes 19 each having a transponder device 6 incorporated in its bottom side. The devices 6 are read with a reader having a loop antenna 10. The antenna may be passed under the shelf to read the devices. It is difficult to reach the boxes at the back of the shelf with the loop antenna, often making it necessary to unload the boxes.

Figure 6 shows how the present invention overcomes this problem. A radiating element 20 in the form of a single turn loop made from adhesive copper tape, and rectangular in shape, is stuck to the underside of the shelf, encircling the area where the transponder devices of a row of boxes (front to back) will be located. The loop antenna 10 of the reader 11 is placed under the front of the shelf and the radiating element enables the transponder at the back of the shelf as well as those at the front to be read.

Figure 7 shows an embodiment of the present invention for reading the transponder devices on items stored within a metal enclosure 14. In Figure 7 the enclosure is cut away for the purpose of illustration but when complete, surrounds the items 15 stored therein. The metal of the enclosure shields the transponder devices 6 marking each item 15 and so prevents reading the devices from outside the enclosure. This is a disadvantage if the enclosure is inconvenient to open, or has been sealed. This embodiment also employs a radiating element 7 in the form of a wire loop having a reader coupling coil 9 and transponder coupling coils 12. The former is mounted on the outside of the enclosure 14 and the latter on the inside. The two are linked by a pair of wires passing through the wall of the enclosure via a feed-through 17 which may be filled with a non-conductive material.

The reader coupling coil 9 is mounted flat on the side of the enclosure but is spaced therefrom to improve the coupling with the reader. Alternatively the coil may be mounted projecting from the enclosure with its axis generally parallel to the wall of the enclosure. This may improve the coupling with the reader but has the disadvantage of the projecting coil being vulnerable to mechanical damage. A compromise is to mount the coil on a hinged flap which lies

flat against the wall of the enclosure for storage but may be opened to a projecting position for reading with the reader 11.

The transponder coil 12 is mounted around the periphery of the inside of the enclosure and so again is sized to cover the likely area of the transponder devices 6.

The enclosure of Figure 7 could be, for example, a container for loading onto a vehicle.

The embodiment of Figure 7 works in the same manner, to transfer signals between the reader 11 and the transponder devices 6 as the beer keg and archive box embodiments described above.

Low frequency radio signals in the range 120 to 140 kHz are commonly used for transponder devices for this kind of application, the frequency for the beer keg application used above being 134 kHz. The archive box embodiment uses a frequency of 13.56 MHz, however.

Since the radiating elements employed have low Q the number of turns used is not critical. One or two turns of the wire for the coils are generally sufficient but more may give better performance.

In some cases it may not be necessary to have distinct coils for coupling to the reader and the transponders; the radiating element could, as in the case of the archive boxes, comprise a single large coil mounted with one portion conveniently located to couple to the loop antenna of the reader and with another portion of the coil being located in the region of the transponder devices.

The embodiments described herein have a radiating element formed from conductive wire. Other forms of conductive material may be used, however, to provide an element with a portion for receiving radio signals from a reader and a portion for radiating those signals to a transponder, the radiating element acting also, of course, to convey signals in the reverse direction.

The embodiments above have been described showing the use of the invention in a separator board, under a shelf and in a container. The invention may equally be used with any other device used to store or package items. Further, some of the embodiments have shown the use of the invention in situations where the goods themselves or that used to store them shield the transponder devices from the reader. This problem does not, however, have to be present for the invention to be useful. It may also be used with advantage to convey the radio signals from the reader to the transponder devices when they are in a location to which it is inconvenient to take the reader.

CLAIMS:

1. A transponder device reading system comprising:

at least one transponder device;

a transponder device reader comprising an antenna for emitting an interrogation radio signal and for receiving a response radio signal emitted by the or each transponder device in response to the interrogation signal;

a radiating element having a radiating portion for coupling radio signals to and from the antenna of the reader and a radiating portion for coupling radio signals to and from the or each transponder device,

wherein the radiating element is so coupled to the transponder device reader and to the or each transponder device, and wherein the radiating element is arranged to transfer radio signals emitted by the antenna of the reader to the or each transponder and to transfer radio signals emitted by the or each transponder to the reader.

2. A storage means container, or packaging element, comprising a radiating element having means for coupling radio signals to and from a transponder device reader and a radiating portion for coupling radio signals to and from at least one transponder device, the radiating element being arranged to transfer an interrogation radio signal emitted by the reader to the or each transponder and to transfer response radio signals emitted by the or each transponder to the reader in response to the interrogation signal, wherein the radiating element is mounted in or on the container or packaging element.

3. A storage means, container or packaging element as claimed in claim 2 wherein the means for coupling to and from the transponder device reader comprises a radiating portion, of the radiating element, for coupling radio signals to and from an antenna of the reader.

4. A storage means, container or packaging element as claimed in claim 2 wherein the means for coupling to and from the transponder device comprises a conductive connector for conductively connecting the radiating element to the reader.

5. A transponder device reading system as claimed in claim 1, comprising a storage means, container or packing element, wherein the said radiating element is mounted in or on the storage means, container or packaging element.

6. A transponder device reading system as claimed in claim 1 or claim 5 or a storage means, container or packaging element as claimed in any one of claims 2 to 4, wherein the radiating element comprises a conductive loop of at least one turn.

7. A transponder device reading system or a storage means, container or packaging element as claimed in claim 6 wherein the conductive loop comprises a wire loop.

8. A transponder device reading system or a storage means, container or packaging element as claimed in claim 6 or claim 7, when dependent on claim 1 or claim 3, wherein the conductive loop has a coil of at least one turn providing the reader coupling portion.

9. A transponder device reading system or a storage means, container or packaging element as claimed in any one of claims 6 to 8, wherein the conductive loop has a coil of at least one turn providing the transponder coupling portion.

10. A transponder device reading system or a storage means, container or packaging element as claimed in claim 9, wherein the conductive loop has a plurality of coils of at least one turn each providing a transponder coupling portion.

11. A transponder device reading system or a storage means, container or packaging element as claimed in any one of claims 6 to 10 wherein the conductive loop has a coil that provides coupling to both the reader and at least one transponder device.

12. A packaging element as claimed in any one of claims 2 to 4, or as claimed in any one of claims 6 to 11, wherein the packaging element is in the form of a separator board for a stack of items.

13. A stack of items at least some of which have a transponder device, the stack comprising layers of said items separated by packaging elements each in the form of a separator board as claimed in claim 12.

14. A stack of items as claimed in claim 13 wherein the stack is terminated both at the top and the bottom by a separator board as claimed in claim 12.

15. A stack of items as claimed in claim 13 or claim 14, wherein said items are beer containers.

16. A stack as claimed in claim 15 wherein the said beer containers are kegs or barrels or casks.

17. A storage means as claimed in any one of claims 2 to 4, or as claimed in any one of claims 6 to 11, wherein the storage means is a shelf.

18. A packaging element as claimed in claim 12, or a stack as claimed in any one of claims 13 to 18 comprised in a transponder device reading system which also comprises the or each said transponder device and said device reader.

19. A method of reading at least one transponder device with a device reader comprising:

providing a radiating element having a portion for coupling radio signals to and from the antenna of the reader and a portion for coupling radio signals to and from the or each transponder device;

emitting an interrogation signal from the antenna of the device reader;

transferring the emitted interrogation signal to the or each transponder with the radiating element;

emitting a response signal from the or each transponder in response to the interrogation signal; and

transferring the or each emitted response signal to the antenna of the reader with the radiating element.

20. A method as claimed in claim 19, wherein the said radiating element is mounted in or on a container or packaging element.

21. A method as claimed in claim 19 or claim 20, wherein the radiating element comprises a conductive loop of at least one turn.

22. A method as claimed in claim 21, wherein the conductive loop has a coil of at least one turn providing the reader coupling portion.

23. A method as claimed in claim 21 or claim 22, wherein the conductive loop has a coil of at least one turn providing the transponder coupling portion.

24. A method as claimed in claim 23, wherein the conductive loop has a plurality of coils of at least one turn each providing a transponder coupling portion.

25. A method as claimed in any one of claims 21 to 24 wherein the conductive loop has a coil that provides coupling to both the reader and at least one transponder device.

26. A method as claimed in any one of claims 21 to 25 wherein the conductive loop comprises a wire loop.

27. A method of reading at least one transponder device with a device reader comprising:

forming a stack as claimed in any one of claims 13 to 17, and

coupling the reader to each said separator board in turn.

28. A radiating element substantially as illustrated by, and as described with reference to, Figures 3 and 4, or Figure 5 and 6, or Figure 7.

29. A method of reading at least one transponder device with a device reader using a radiating element, substantially as herein described.

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Application No: GB 0006252.1 **Examiner:** Jared Stokes
Claims searched: 1 to 27 **Date of search:** 10 November 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): H4L (LADA, LCL, LCR, LCT, LCX)

Int Cl (Ed.7): G06K (7/015, 7/08, 7/10)
H04B (5/00, 5/02, 7/145)

Other: On-Line - EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X,Y	GB 2 288 103 A	(Hughes) See whole document	X: 1-3, 5-9, 19-23,26 Y: 4
X	WO 97/49076 A1	(Integrated) See whole document	1-9,11,17, 19-23,25, 26
Y	WO 96/41296 A1	(Motorola) See abstract	4
X	US 5 523 750	(de Vall) See whole document	1-3,5-9, 11,19-23, 25,26

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.